



Bird Community Monitoring at Tallgrass Prairie National Preserve, Kansas

Status Report

Natural Resource Report NPS/HTLN/NRR—2015/1039



ON THE COVER

Landscape at Tallgrass Prairie National Preserve, Kansas
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Executive Summary

In 2001, the Heartland I&M Network (HTLN) initiated breeding bird surveys on Tallgrass Prairie National Preserve, Kansas to assess the ecological integrity of the Preserve's habitat. Birds, an important component of ecosystems, serve as good indicators of the effects of changes in the habitat of an ecosystem. In the 14 years since initiating bird surveys, the preserve has been sampled 13 years, resulting in 1682 plot visits and 113 different bird species recorded, of which 94 have the potential to breed within the Preserve. All plot visits involved a 5-min sampling period in which birds were recorded. Twenty bird species were recorded in sufficient numbers to calculate annual abundances and population trends. Five species – Dickcissel, Eastern Meadowlark, Mourning Dove, Northern Cardinal, and Red-bellied Woodpecker – have populations that increased significantly over the years, suggesting that habitat on the Preserve is changing to meet their needs. Western Meadowlark populations declined significantly on the Preserve, suggesting they are less favored by the current habitat. Five species found to be declining in the bird conservation region – Eastern Kingbird, Grasshopper Sparrow, Horned Lark, Northern Bobwhite, and Red-winged Blackbird – had stable populations on the Preserve. This would suggest that the current management practice on the Preserve is at least having no significant negative impact on their numbers.

Comparing management philosophies between earlier (2001 through 2005) and later years (2005 through 2014) on the Preserve helps explain some of the bird trends observed. The number of hectares burned annually declined between the earlier and later years, as did the stocking rates of cattle. A small herd of Bison replaced cattle in Windmill Pasture as well. The early higher intensity management created habitat with shorter and sparser vegetation favored by Western Meadowlark, and the later management produces taller and denser vegetation favored by other species – Eastern Meadowlark, Dickcissel, Greater Prairie-chicken, Henslow's Sparrow, Upland Sandpiper. Positive trends in bird diversity on the Preserve also suggest that the less intense management favors the conservation of the bird community as a whole. Although species richness and the distribution of individuals within species did not increase significantly, both values trended positively as well.

This report provides current regional and local trends for breeding birds for future comparisons with bird data collected as part of the long-term monitoring efforts at TAPR. With this report, Preserve staff can better account for the potential effects of management actions on breeding birds. Monitoring data also provide Preserve staff with additional information useful for interpreting the important natural resources, birds.

Acknowledgments

We would like to thank the staff of Tallgrass Prairie National Preserve, Kansas for allowing us access to the Preserve during our breeding bird surveys and for assisting with bird surveys. We would especially like to thank Preserve staff Kristen J. Hase for her coordination of surveys in

years when the Preserve was not sampled by HTLN staff. A debt of thanks is owed Dr. Gary Willson and an anonymous reviewer for their valuable reviews that improved the scope and content of this report.

Introduction

Birds are an important component of park ecosystems, as their high body temperature, rapid metabolism, and high ecological position in most food webs make them good indicators of the effects of local and regional changes in ecosystems. It has been suggested that management activities, intended to preserve habitat for bird populations, such as for neotropical migrants, can have the added benefit of preserving entire ecosystems and their attendant ecosystem services (Karr 1991, Maurer 1993). Additionally, the National Park Service plays a role in bird conservation, as it complies with the requirements of the Migratory Bird Treaty Act of 1918 (as amended) and the Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. Moreover, birds have a tremendous following among the public and many parks provide information on the status and trends of birds through their interpretive programs. Bird monitoring is also critical as widespread habitat loss to agriculture and urban and industrial development threaten the integrity of the region for birds.

Tallgrass Prairie National Preserve (TAPR), Kansas is located in the west-central section of the Eastern Tallgrass Prairie Bird Conservation Region (Figure 1). The Eastern Tallgrass Prairie Bird Conservation Region is one of 67 regions identified in the North American Bird Conservation Initiative (NABCI). Started in 1999, the NABCI is a coalition of government agencies and private organizations in the United States working to ensure the long-term health of North America's native bird populations (NABCI 2013).

The Eastern Tallgrass Prairie Bird Conservation Region historically consists of the tallest and lushest grasslands of the Great Plains (NABCI 2013). However, forests dominate the region in the east creating an oak-savanna ecotone between the eastern woodlands and the western prairie. The western most section of the region where TAPR is located consists of the Flint Hills with its remnant native tallgrass prairie (Fitzgerald et al. 2000). The rocky rolling terrain of the Flint Hills has been largely untouched by the plow. Threats to the upland and wetland habitats of this region include urbanization, recreational development, and agricultural expansion. High priority grassland birds that persist in some areas include the Greater Prairie-Chicken (*Tympanuchus cupido*) and Henslow's Sparrow (*Ammodramus henslowii*). Cerulean Warblers (*Dendroica cerulea*) are in some wooded areas, and Red-headed Woodpecker (*Melanerpes erythrocephalus*) leads the list of savanna specialists (NABCI 2013). Approximately 120 species of breeding birds can be found in the habitat of the Flint Hills around TAPR (Thompson et al. 2011).

Data collected during the U.S. Geological Survey's annual North American Breeding Bird Surveys (BBS) between 1966 and 2012 indicate that a number of bird species breeding at TAPR show evidence of long-term population decline (Sauer et al. 2014). In fact, 44% of the species

have populations reported to be in decline, with species such as the Black-billed Cuckoo (*Coccyzus erythrophthalmus*), Grasshopper Sparrow (*Ammodramus savannarum*), Greater Prairie-Chicken, Loggerhead Shrike (*Lanius ludovicianus*), Red-headed Woodpecker, and Western Meadowlark (*Sturnella neglecta*) declining at alarming rates.

Long-term trends in community composition and abundance of breeding bird populations provide one measure for assessing the ecological integrity and sustainability of a system. We will use trends in the composition and abundance of bird populations as long-term indicators of ecosystem integrity at TAPR. *Ecosystem integrity* is defined as the system's capability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitats of the region (Karr and Dudley 1981). Research has demonstrated that birds serve as good indicators of changes in ecosystems (Cairns et al. 2004, Mallory et al. 2006, Wood et al. 2006). Therefore, changes in the numbers and composition of bird communities may reflect the result of management actions taken to restore and maintain the cultural landscape at TAPR.

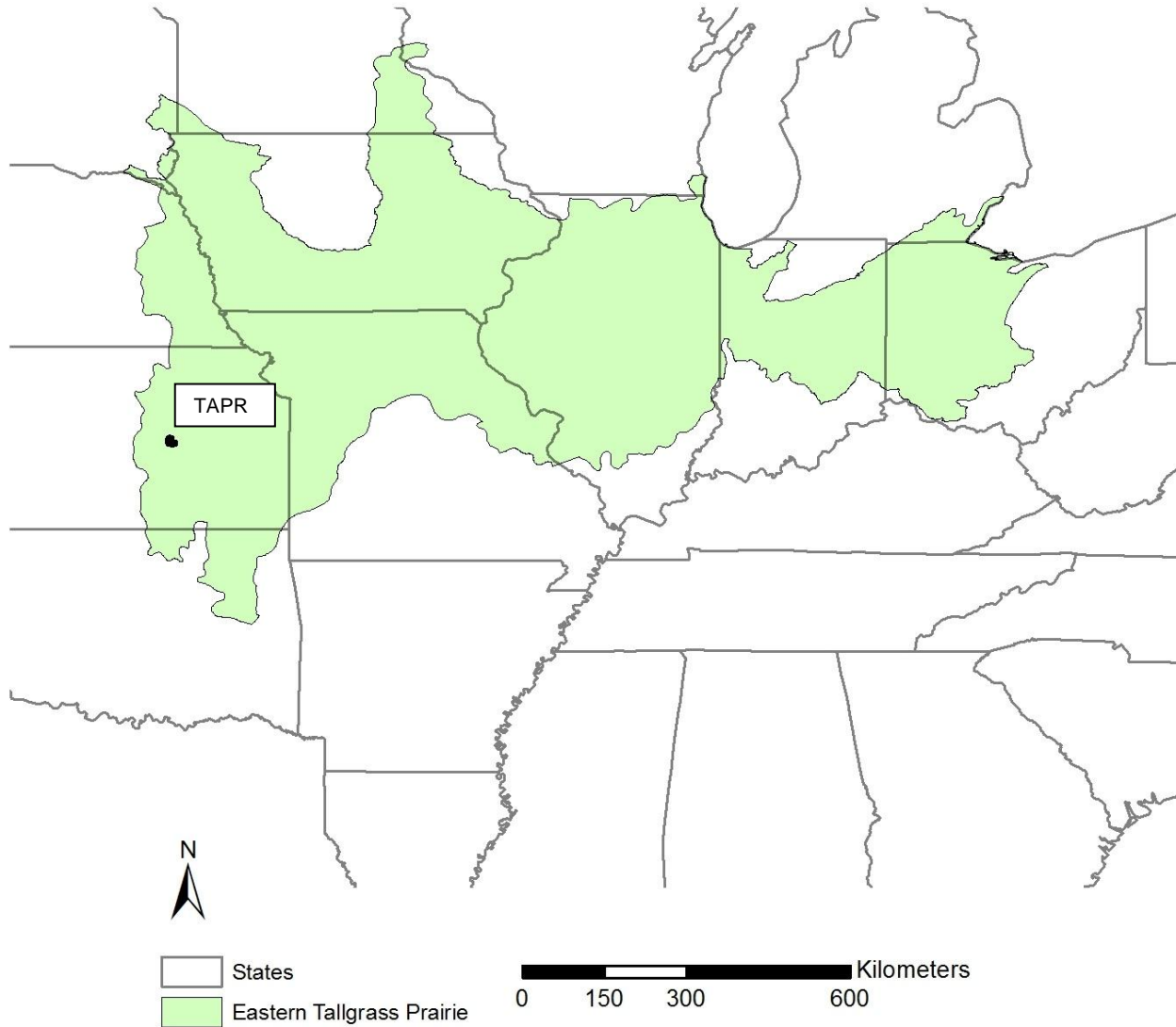


Figure 1. Location of Tallgrass Prairie National Preserve (TAPR), Kansas within the Eastern Tallgrass Prairie Bird Conservation Region.

Objectives

There are two primary objectives for monitoring breeding birds at Tallgrass Prairie National Preserve:

- Identify significant temporal changes in the species composition and abundance of bird communities that occur at TAPR during the breeding season.
- Improve our understanding of breeding bird – habitat relationships and the effects of management actions such as prairie restorations or prescribed fire on bird populations, by

correlating changes in bird community composition and abundance with changes in specific habitat variables (e.g., vegetation structure, ground cover).

As a first step in meeting monitoring objectives, this report summarizes species composition and population trends for birds recorded during the thirteen years of monitoring.

Methods

Site Selection

Permanent monitoring locations or 'plots' were created by overlaying a systematic grid of 400 x 400 meter cells (originating from a random start point) across the grassland habitat on the Preserve, and placing plots at the intersection of grid lines. The orientation of the systematic grid was rotated 34 degrees from north to prevent sampling sites from being influenced by man-made features oriented along cardinal directions. Riparian corridors were identified as a separate stratum, with sampling extending 125 m on either side of the stream channel (Palmer and Fox Creeks). The riparian stratum makes up 5.3% of the total area (4398 ha) at TAPR. Within the riparian stratum, plots were located at 250 m intervals along the extent of a stream. Any plots from the overall grid that fell within the riparian stratum were discarded. We established 242 grassland (including brome plots) and 18 riparian plots (Figure 1). Monitoring occurred on 54 to 260 sites annually depending on year (Table 1).

To limit the effort needed to complete annual breeding bird surveys from 2004 through 2008, an interpenetrating, split panel revisit plan [1-0,1-4] was utilized in which plots in one panel were sampled in all years ($n = 41$); and plots in five additional panels were visited on a rotating basis once every five years ($n = 40$ or 41). Panel membership was assigned to all plots in the systematic sample by numbering plots sequentially along transects aligned northwest to southeast, starting with the most northeastern plot. Assignment to panels A through F was done in a repeated fashion to the sequenced numbers (i.e. number 1 = A, 2 = B, 3 = C, 4 = D, 5 = E, 6 = F, 7 = A, 8 = B and so on). To determine membership in the annual panel and the sequence of the remaining panels, the six letters (A – F) were randomly sequenced. The result was E, A, D, B, F and C. Therefore, panel E was visited annually, panel A in years 1, panel D in years 2, B in years 3, and so on. Along with two panels, annual sampling included the 18 riparian sites resulting in an annual work load of approximately 100 sites per year, with 50 percent of the annual sampling effort in upland prairie allocated to the annually sampled panel. The interpenetrating, split panel revisit plan was designed by statistical consultant T. McDonald, Western Ecosystems Technology, Inc, Cheyenne, WY.

Starting in 2009 the breeding bird monitoring was conducted by Preserve staff, allowing HTLN to modify their sampling schedule to visit the Preserve once every fourth year. To facilitate this change Preserve staff was asked to visit sites identified in panel E and riparian plots, and to sample as many other plots as their schedules would allow. HTLN monitored all available plots during their fourth year visits, 2010 and 2014.

Table 1. Number of plots sampled, and sampling dates for breeding bird surveys conducted at Tallgrass Prairie National Preserve, Kansas, by year. Also listed are observer(s) who conducted the surveys.

Year	Sampling Dates	Number of Plots Sampled	Observer(s)
2001	May 22 – June 13	176	D.G. Peitz*
2002	May 20 – June 20	260	D.G. Peitz*
2004	May 10 – May 27	97	D.G. Peitz*
2005	May 17 – May 24	97	D.G. Peitz*
2006	May 16 – May 23	99	D.G. Peitz*
2007	May 17 – May 23	89	D.G. Peitz*
2008	June 2 – June 8	95	D.G. Peitz*
2009	May 30 – June 4	58	C.D. Hase, D.L. McCullough, J.A. Rundell, and K.J. Hase
2010	May 11 – May 24	260	D.G. Peitz* and D.L. McCullough
2011	May 23 – June 3	58	C.D. Hase, D.L. McCullough, J.A. Rundell, and K.J. Hase
2012	May 24 – June 13	54	A.D. Page, A.U. Rutter, D.L. McCullough, J.A. Rundell, K.J. Hase, K.M. Rice, M.S. Wormington, and R.A. Guffy
2013	May 6 – June 17	58	D.L. McCullough and K.J. Hase
2014	May 13 – May 21	259	D.G. Peitz* and D.W. Londe*

*Heartland I&M Network staff.

During bird surveys in 2001 through 2008, and 2010, and 2014, monitoring plots were located using navigation waypoints (Peitz et al. 2008) in a GPS unit and temporarily marked with 36-inch pin flags to aid in relocating the plots for habitat assessment, eliminating the need for permanent plot markers. We collected pin flags from each plot once the habitat work was completed. During bird surveys in other years when habitat assessments were not conducted, monitoring plots were located using a GPS unit. However, plot locations were not marked with pin flags.

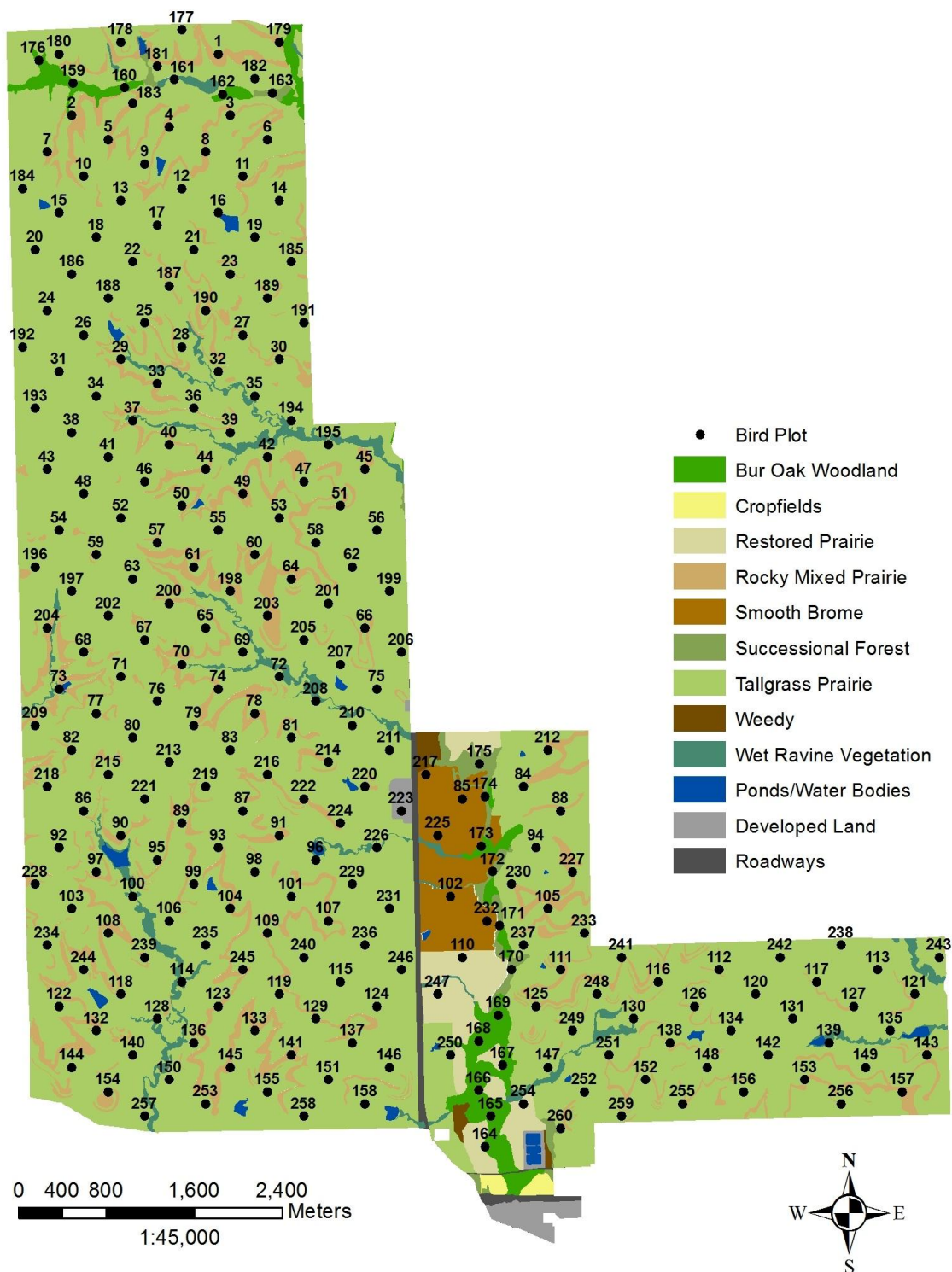


Figure 2. Bird plot locations on Tallgrass Prairie National Preserve, Kansas. Vegetation mapping and classification provided by Kindscher et al. (2011).

Bird Surveys

Bird surveys followed methods outlined in the bird monitoring protocol by Peitz et al. (2008) and summarized in this report. Variable circular plot counts, a point count methodology that incorporates a measure of detectability into population estimates, were used to survey birds present (Fancy 1997). All birds seen or heard at plots during 5-min sampling periods were recorded along with their corresponding distance from observer. For most species, we recorded each individual bird as a separate observation. For species that usually occur in clusters or flocks, the units recorded were cluster or flock size, and not the individual bird. During analysis, each individual in a cluster or flock was treated as a separate observation. After completing a count at a plot and filling out the data sheet, the observer navigated to the next plot using a GPS unit. While traveling between plots, the observer was vigilant for the presence of species not recorded during timed surveys. These species help formulate a more complete species list for the Preserve by identifying species missed during timed surveys. However, these observations were not included in any analysis as they did not directly relate to any individual plot. We sampled birds during a period when it was light enough to observe birds to four hours after sunrise.

Variable circular plot counts were conducted in an attempt to get an “instantaneous count” of all birds present. The observer recorded birds flushed from a plot when approached and the counts were started as soon as the observer reached plot center. We recorded all birds seen or heard, including flyovers, along with distance from the observer when possible. For this report, all birds seen or heard during the 5-min survey are included. Individual birds recorded from a previous plot were noted and excluded from analysis except when developing detection functions using Distance software.

Data Analysis

Prior to summary analysis, the residency status (migrant, permanent resident, summer resident, winter resident) of each bird species recorded was determined. Identifying the residency of each species helps to exclude migrants from analysis of breeding birds within TAPR. Proportion of plots occupied by each bird species was calculated (total number of plots occupied by a species/plots surveyed) and reported in Appendix 1 and 2. For species with greater than 60 observations recorded, Distance software (Distance 6.0 Release 2) was used to determine the park-wide abundance of each (Buckland et al. 2001). A central part of the analysis in Distance is the modeling of a detection function to account for individuals present but not observed before calculating species abundance. Four candidate functions plus series expansion; Half-normal + Cosine, Uniform + Cosine, Half-normal + Hemite polynomial, and Hazard-rate + Cosine were considered in determining the detection function of each species, and the most robust models were selected by Distance based on the lowest Akaike Information Criteria (AIC) values. The Hazard-rate + Cosine function was selected for 15 species, Eastern Kingbird, Eastern Meadowlark, Eastern Wood-pewee, Grasshopper Sparrow, Henslow's Sparrow, Horned Lark, Killdeer, Lark Sparrow, Mourning Dove, Northern Bobwhite, Northern Cardinal, Red-bellied Woodpecker, Red-winged Blackbird, Tufted Titmouse, Upland Sandpiper. The Half-normal +

Cosine function was selected for four species, Brown-headed Cowbird, Dickcissel, Great Crested Flycatcher, Western Meadowlark. The Uniform + Cosine function was selected for Greater Prairie Chicken. Abundances for these species are reported in Appendix 1. For species with fewer than 60 observations, park-wide abundance was calculated by first deriving a species density from observations recorded within a 100-m radius (3.14ha) around each plot center and then calculating abundance based on average plot densities. Park-wide abundances for species with less than 60 observations are reported in Appendix 2.

For species with adequate abundance, those with greater than 60 observations (20 species), trends were calculated by regressing abundance against survey years. Autocorrelation in abundance values between years was assessed using the Durbin-Watson test and found to be insignificant at the $p = 0.05$ level for 85% of the species. A Shapiro-Wilks test performed on each species abundances demonstrated error terms were distributed normally. Homoscedasticity in error terms (no identifiable patterns in plotted residuals) were assessed by plotting residuals against fitted values. Cook's distance identified no significant outliers in plotted residuals. Therefore, a simple linear regression with the slope of the equation equaling a species population trend was applied (R Development Core Team 2008) to each species. For those species with significant autocorrelation, a non-parametric analogue of linear regression, the modified Mann Kendal Trend Test, was employed using the Time Trends software package (Time Trends Version 3.31 2012). For this report we also obtained regional breeding bird trends for the Eastern Tallgrass Prairie Bird Conservation Region during the periods between 2001 and 2013 (Appendix 3; Sauer et al. 2014), and compared these trends with those seen in the bird populations at TAPR.

Trends in the diversity, richness, and species distribution evenness of the breeding bird community on the Preserve were assessed following methods outlined above. Prior to trend analysis, bird community diversity values were calculated annually using the Shannon Diversity Index:

$$H' = -\sum(n_i/N)\ln(n_i/N)$$

where n_i/N is the proportion of the total number of individuals in a population consisting of the i^{th} species (Shannon, 1949). Species richness values were determined as the total number of bird taxa recorded annually. Species distribution evenness values were calculated using Pielou (J):

$$J' = H' / H_{max}$$

where H' is the Shannon Diversity Index and H_{max} is the maximum possible diversity for a given number of species if all species are present in equal numbers ($\ln(\text{annual species richness})$). J' is a measure of how evenly individuals are distributed within a community when compared to the equal distribution and maximum diversity a community can have (Pielou, 1969).

Results

Bird Surveys

Between years 2001 and 2014, 54 to 260 plots at TAPR were surveyed annually for breeding birds (Table 1), excluding 2003 when no plots were sampled. During this period, 1682 plots were visited, and 113 different bird species were recorded, 94 of which have the potential to breed within the Preserve (Table 2; Thompson et al. 2011). However, six breeding species, Blue-winged Teal (*Anas discors*), Burrowing Owl (*Athene cunicularia*), Eurasian Collared-dove (*Streptopelia decaocto*), Great Egret (*Ardea alba*), Green Heron (*Butorides virescens*), and Pileated Woodpecker (*Dryocopus pileatus*) were only observed outside 5-min survey periods. One winter resident, Song Sparrow (*Melospiza melodia*), and three migrants, Semipalmated Sandpiper (*Calidris pusilla*), Sora (*Porzana carolina*), and White-faced Ibis (*Plegadis chihi*) were also recorded outside 5-min survey periods. Seventeen species recorded, including 13 breeding species, are considered *species of concern* for the Eastern Tallgrass Prairie Bird Conservation Region (U.S. Fish and Wildlife Service 2008). Nine breeding species - Dickcissel (*Spiza Americana*), Eastern Meadowlark (*Sturnella magna*), Grasshopper Sparrow, Greater Prairie-chicken, Henslow's Sparrow, Horned Lark (*Eremophila alpestris*), Northern Harrier (*Circus cyaneus*), Upland Sandpiper (*Bartramia longicauda*), and Western meadowlark –, and four migrant species – Bobolink (*Dolichonyx oryzivorus*), Savanna Sparrow (*Passerculus sandwichensis*), Sedge Wren (*Cistothorus platensis*), and Vesper Sparrow (*Pooecetes gramineus*) - are grassland obligates (U.S. Geological Survey 2014).

Table 2. Bird species recorded during breeding bird surveys at Tallgrass Prairie National Preserve, Kansas in 2001 through 2014. The American Ornithologists' Union Code (AOU code) and residency status of each species is given.

Common name	Species name	AOU code	Residency ¹
Acadian Flycatcher	<i>Empidonax virescens</i>	ACFL	M
American Crow	<i>Corvus brachyrhynchos</i>	AMCR	R
American Goldfinch	<i>Carduelis tristis</i>	AMGO	R
American Robin	<i>Turdus migratorius</i>	AMRO	R
American Tree Sparrow	<i>Spizella arborea</i>	ATSP	WR
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BAEA	WR
Baltimore Oriole	<i>Icterus galbula</i>	BAOR	SR
Bank Swallow	<i>Riparia riparia</i>	BANS	SR
Barn Swallow	<i>Hirundo rustica</i>	BARS	SR
Barred Owl	<i>Strix varia</i>	BDOW	R
Bell's Vireo	<i>Vireo bellii</i>	BEVI	SR
Belted Kingfisher	<i>Megasceryle alcyon</i>	BEKI	R
Bewick's Wren	<i>Thryomanes bewickii</i>	BEWR	SR
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	BBCU	SR
Black-capped Chickadee	<i>Poecile atricapillus</i>	BCCH	R
Blue Jay	<i>Cyanocitta cristata</i>	BLJA	R
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	BGGN	SR

Table 2. Bird species recorded during breeding bird surveys at Tallgrass Prairie National Preserve, Kansas in 2001 through 2014. The American Ornithologists' Union Code (AOU code) and residency status of each species is given.

Common name	Species name	AOU code	Residency ¹
Blue Grosbeak	<i>Passerina caerulea</i>	BLGR	SR
Blue-winged Teal*	<i>Anas discors</i>	BWTE	SR
Bobolink	<i>Dolichonyx oryzivorus</i>	BOBO	M
Brown Creeper	<i>Certhia americana</i>	BRCR	WR
Brown-headed Cowbird	<i>Molothrus ater</i>	BHCO	R
Brown Thrasher	<i>Toxostoma rufum</i>	BRTH	SR
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	BBSA	M
Burrowing Owl*	<i>Athene cunicularia</i>	BUOW	SR
Canada Goose	<i>Branta canadensis</i>	CAGO	R
Carolina Wren	<i>Thryothorus ludovicianus</i>	CARW	R
Cattle Egret	<i>Bubulcus ibis</i>	CAEG	SR
Cedar Waxwing	<i>Bombycilla cedrorum</i>	CEDW	R
Chipping Sparrow	<i>Spizella passerina</i>	CHSP	SR
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	CLSW	SR
Common Grackle	<i>Quiscalus quiscula</i>	COGR	R
Common Nighthawk	<i>Chordeiles minor</i>	CONI	SR
Common Yellowthroat	<i>Geothlypis trichas</i>	COYE	SR
Dickcissel	<i>Spiza americana</i>	DICK	SR
Downy Woodpecker	<i>Picoides pubescens</i>	DOWO	R
Eastern Bluebird	<i>Sialia sialis</i>	EABL	R
Eastern Kingbird	<i>Tyrannus tyrannus</i>	EAKI	SR
Eastern Meadowlark	<i>Sturnella magna</i>	EAME	R
Eastern Phoebe	<i>Sayornis phoebe</i>	EAPH	SR
Eastern Towhee	<i>Pipilo erythrophthalmus</i>	EATO	SR
Eastern Wood-pewee	<i>Contopus virens</i>	EAWP	SR
Eurasian Collared-dove*	<i>Streptopelia decaocto</i>	ECDO	R
Field Sparrow	<i>Spizella pusilla</i>	FISP	R
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	GRSP	SR
Gray Catbird	<i>Dumetella carolinensis</i>	GRCA	SR
Great Blue Heron	<i>Ardea herodias</i>	GBHE	R
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	GCFL	SR
Great Egret*	<i>Ardea alba</i>	GREG	SR
Great Horned Owl	<i>Bubo virginianus</i>	GHOW	R
Greater Prairie Chicken	<i>Tympanuchus cupido</i>	GPCH	R
Great-tailed Grackle	<i>Quiscalus mexicanus</i>	GTGR	R
Green Heron*	<i>Butorides virescens</i>	GRHE	SR
Golden-winged Warbler	<i>Vermivora chrysoptera</i>	GWWA	M
Hairy Woodpecker	<i>Picoides villosus</i>	HAWO	R
Henslow's Sparrow	<i>Ammodramus henslowii</i>	HESP	SR
Horned Lark	<i>Eremophila alpestris</i>	HOLA	R

Table 2. Bird species recorded during breeding bird surveys at Tallgrass Prairie National Preserve, Kansas in 2001 through 2014. The American Ornithologists' Union Code (AOU code) and residency status of each species is given.

Common name	Species name	AOU code	Residency ¹
House Finch	<i>Carpodacus mexicanus</i>	HOFI	R
House Wren	<i>Troglodytes aedon</i>	HOWR	SR
Indigo Bunting	<i>Passerina cyanea</i>	INBU	SR
Kentucky Warbler	<i>Oporornis formosus</i>	KEWA	SR
Killdeer	<i>Charadrius vociferus</i>	KILL	SR
Lark Sparrow	<i>Chondestes grammacus</i>	LASP	SR
Loggerhead Shrike	<i>Lanius ludovicianus</i>	LOSH	R
Louisiana Waterthrush	<i>Seiurus motacilla</i>	LOWA	SR
Mallard	<i>Anas platyrhynchos</i>	MALL	R
Mourning Dove	<i>Zenaida macroura</i>	MODO	R
Northern Bobwhite	<i>Colinus virginianus</i>	NOBO	R
Northern Cardinal	<i>Cardinalis cardinalis</i>	NOCA	R
Northern Flicker	<i>Colaptes auratus</i>	YSFL	R
Northern Harrier	<i>Circus cyaneus</i>	NOHA	R
Northern Mockingbird	<i>Mimus polyglottos</i>	NOMO	R
Northern Parula	<i>Parula americana</i>	NOPA	SR
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	NRWS	SR
Orchard Oriole	<i>Icterus spurius</i>	OROR	SR
Pied-billed grebe	<i>Podilymbus podiceps</i>	PBGR	M
Pileated Woodpecker*	<i>Dryocopus pileatus</i>	PIWO	R
Prairie Warbler	<i>Dendroica discolor</i>	PRAW	M
Prothonotary Warbler	<i>Protonotaria citrea</i>	PROW	SR
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	RBWO	R
Red-eyed Vireo	<i>Vireo olivaceus</i>	REVI	SR
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	RHWO	R
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RTHA	R
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	RWBL	R
Ring-necked Pheasant	<i>Phasianus colchicus</i>	RPHE	R
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	RTHU	SR
Savanna Sparrow	<i>Passerculus sandwichensis</i>	SAVS	M
Scarlet Tanager	<i>Piranga olivacea</i>	SCTA	SR
Scissor-tailed Flycatcher	<i>Tyrannus forficatus</i>	STFL	SR
Semipalmated Sandpiper*	<i>Calidris pusilla</i>	SESA	M
Sedge Wren	<i>Cistothorus platensis</i>	SEWR	M
Song Sparrow*	<i>Melospiza melodia</i>	SOSP	WR
Sora*	<i>Porzana carolina</i>	SORA	M
Spotted Sandpiper	<i>Actitis macularius</i>	SPSA	SR
Summer Tanager	<i>Piranga rubra</i>	SUTA	SR
Tufted Titmouse	<i>Baeolophus bicolor</i>	TUTI	R
Turkey Vulture	<i>Cathartes aura</i>	TUVU	SR

Table 2. Bird species recorded during breeding bird surveys at Tallgrass Prairie National Preserve, Kansas in 2001 through 2014. The American Ornithologists' Union Code (AOU code) and residency status of each species is given.

Common name	Species name	AOU code	Residency ¹
Upland Sandpiper	<i>Bartramia longicauda</i>	UPSA	SR
Veery	<i>Catharus fuscescens</i>	VEER	M
Vesper Sparrow	<i>Pooecetes gramineus</i>	VESP	M
Warbling Vireo	<i>Vireo gilvus</i>	WAVI	SR
Western Kingbird	<i>Tyrannus verticalis</i>	WEKI	SR
Western Meadowlark	<i>Sturnella neglecta</i>	WEME	R
White-breasted Nuthatch	<i>Sitta carolinensis</i>	WBNU	R
White-eyed Vireo	<i>Vireo griseus</i>	WEVI	M
White-faced Ibis*	<i>Plegadis chihi</i>	WFIB	M
Wild Turkey	<i>Meleagris gallopavo</i>	WITU	R
Wood Duck	<i>Aix sponsa</i>	WODU	SR
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	YBSA	WR
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	YBCU	SR
Yellow-breasted Chat	<i>Icteria virens</i>	YBCH	SR
Yellow-throated Vireo	<i>Vireo flavifrons</i>	YTVI	SR
Yellow Warbler	<i>Dendroica petechia</i>	YEWA	SR

* Species recorded between point transects or other times outside of 5-min survey periods.

¹ Residency: M = late migrant or transient; SR = summer resident; R = year around resident; WR = winter resident according to Thompson et al. (2011).

Species names are valid and verified names taken from the Integrated Taxonomic Information System web site (ITIS 2014, accessed 11 June 2014).

Bolded species names are those species considered of conservation concern for the Eastern Tallgrass Prairie Bird Conservation Region (U.S. Fish and Wildlife Service 2008).

Twenty breeding species were observed in sufficient numbers to calculate annual abundances with some degree of confidence (Appendix 1). Five of the 20 species - Dickcissel, Eastern Meadowlark, Mourning Dove (*Zenaida macroura*), Northern Cardinal (*Cardinalis cardinalis*), and Red-bellied Woodpecker (*Melanerpes carolinus*) - have populations with significant increases over the 13 monitoring years since 2001 (Table 3). However, one species, Western Meadowlark has a population that is in significant decline on the Preserve. Trend results with the exception of those for the Eastern Meadowlark mirror trends reported by Sauer et al. (2014, Appendix 3) for the Eastern Tallgrass Prairie Bird Conservation Region. Trends for the remaining 14 species were neither increasing nor decreasing significantly on the preserve during the survey period. However, within the bird conservation region, Eastern Kingbird (*Tyrannus tyrannus*), Grasshopper Sparrow, Horned Lark, Northern Bobwhite (*Colinus virginianus*), and Red-winged Blackbird (*Agelaius phoeniceus*) are declining, and Henslow's Sparrow, Killdeer (*Charadrius vociferous*), and Lark Sparrow (*Chondestes grammacus*) are increasing.

Table 3. Trends, annual change in abundance (individuals) of breeding birds recorded on Tallgrass Prairie National Preserve, Kansas (TAPR) for years 2001 through 2014.

Common name	Change in individuals	95% Confidence Interval		p-value
		Lower	Upper	
Brown-headed Cowbird	15.07	-5.50	35.63	0.14
Dickcissel	177.35	95.56	259.14	<0.01
Eastern Kingbird	-3.21	-16.76	10.34	0.61
Eastern Meadowlark*	124.86	66.07	180.91	<0.01
Eastern Wood-pewee	29.85	-5.83	65.53	0.09
Grasshopper Sparrow	-182.20	-487.26	122.86	0.22
Great Crested Flycatcher	-9.42	-51.50	32.66	0.63
Greater Prairie Chicken	1.63	-3.11	6.38	0.47
Henslow's Sparrow	28.93	-17.16	75.02	0.19
Horned Lark	-22.58	-55.73	10.57	0.16
Killdeer*	-7.45	-27.80	2.31	0.20
Lark Sparrow	-15.65	-50.98	19.68	0.35
Mourning Dove	13.14	0.92	25.35	0.04
Northern Bobwhite	0.90	-0.33	2.12	0.14
Northern Cardinal	38.52	6.28	70.76	0.02
Red-bellied Woodpecker	28.10	1.56	54.65	0.04
Red-winged Blackbird	-4.96	-12.57	2.62	0.18
Tufted Titmouse	18.64	-6.21	43.49	0.13
Upland Sandpiper	4.16	-9.48	17.79	0.52
Western Meadowlark*	-84.80	-160.49	-14.63	0.02

Bolded species names are those species considered of conservation concern for the Eastern Tallgrass Prairie Bird Conservation Region (U.S. Fish and Wildlife Service 2008).

Trends were determined using Simple Linear Regression Analysis (R Development Core Team 2008) unless denoted with an asterisk (*). For those species trends were determined using the nonparametric modified Mann Kendall Trend Test (Time Trends Version 3.31 2012).

Diversity in the breeding bird community on the Preserve increased significantly over the 13 monitoring years since 2001 (Figure 3). However, species richness and the evenness that individuals were distributed across each species remained unchanged over the same time period. For the bird community on the Preserve richness averaged 53.31 species annually. These results should be interpreted with caution, however, as inter-annual variability in the number of plots sampled may be influencing changes in these metrics.

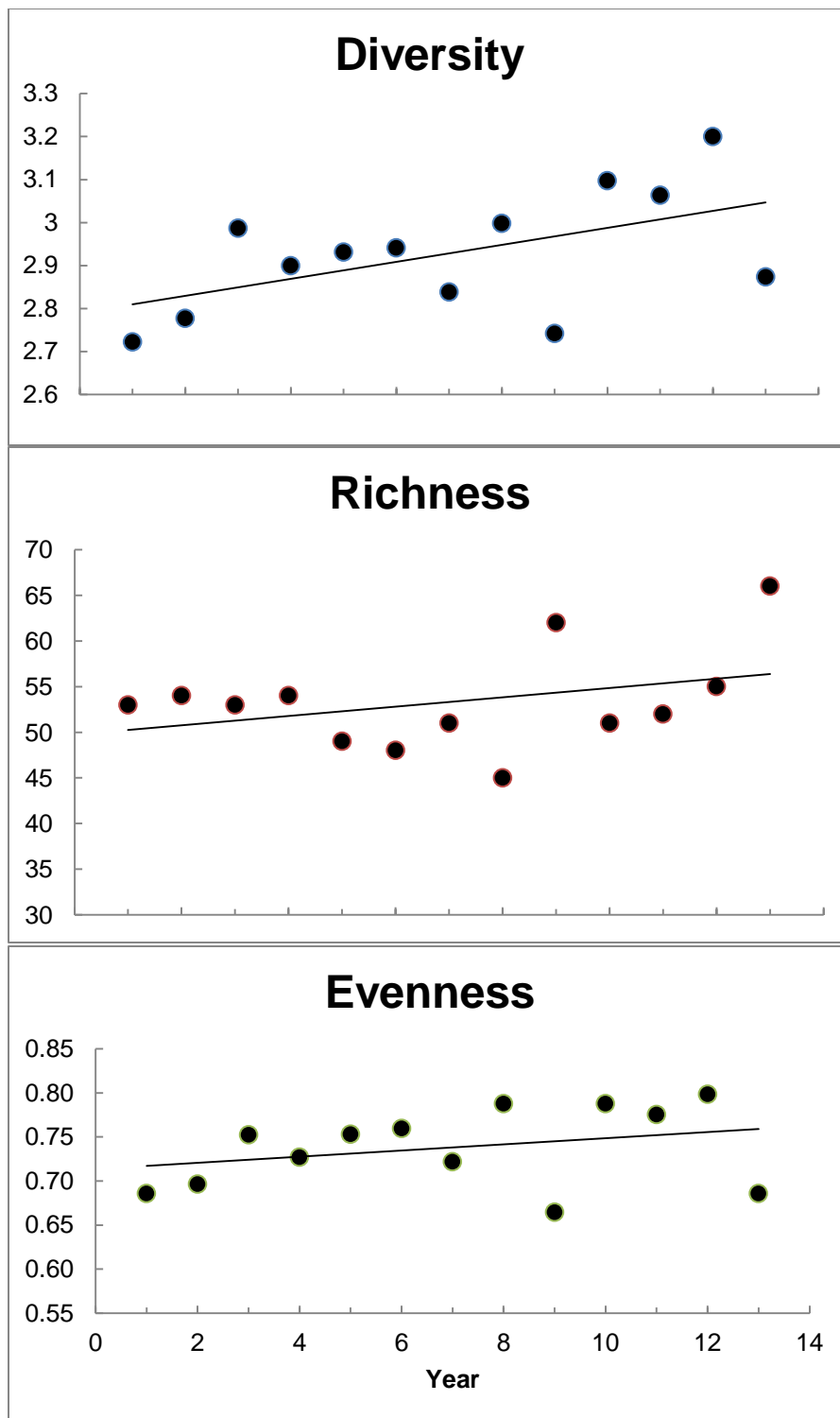


Figure 3. Trends in bird community Diversity ($y = 0.020x - 2.790$; $p = 0.05$), Richness ($y = 0.511x - 49.731$; $p = 0.23$), and species distribution Evenness ($y = 0.004x - 0.714$; $p = 0.31$) on Tallgrass Prairie National Preserve, Kansas between 2001 and 2014.

Discussion

Breeding bird surveys were initiated at TAPR in 2001 to assist the Preserve in assessing the integrity of habitat through time. During the 13 monitoring years since 2001, 113 bird species have been recorded. Ninety-four are permanent or summer residents to the area (Thompson et al. 2011). Therefore, these 94 species have some value in characterizing the breeding bird community of the Preserve, and the habitat upon which they rely. These 94 species represent approximately 78% of the species that could reasonably be expected to have breeding populations on the Preserve (Thompson et al. 2011).

Habitat availability and quality dictates bird population trends within a region (in this case the Eastern Tallgrass Prairie Bird Conservation Region). Similarly, locally available habitat predicates the species expected to be represented at the locale. A lack of habitat in sufficient quantity locally to sustain representatives of a regionally common species will limit the local distribution of that species. Identifying regional trends in breeding birds observed at TAPR is the first step in assessing natural variability, versus the potential local effects of habitat management. For instance, if the prevailing trend in a species regionally is negative, and abundances is low, then efforts to manage habitat for that species will in all likelihood have little success. However, for species that are regionally common or have populations trending upward, TAPR may be able to enhance local populations through habitat management.

With regards to the five species with significantly positive population trends on the Preserve - Dickcissel, Eastern Meadowlark, Mourning Dove, Northern Cardinal, and Red-bellied Woodpecker - the current habitat is such that it benefits their existence. This is especially true for the Eastern Meadowlark whose population for the larger Eastern Tallgrass Prairie Bird Conservation Region has been in decline over the same time period. Co-occurring with increasing Eastern Meadowlark numbers is a decline in Western Meadowlark numbers as a result of changing habitat. Comparing the early years of management on the Preserve (2001 through 2005) with the later years (2005 through 2014) demonstrates changing management philosophies, and helps explain the increase in Eastern Meadowlark and decrease in Western Meadowlark numbers. The number of hectares burned annually declined an average of 48%, and stocking rates declined on average from one animal per 0.40 ha to one animal per 0.58 ha. And in 2009, cattle were removed from the 436 ha Windmill pasture and replaced with 13 head of Bison (*Bison bison*). By 2013, 23 head of Bison were roaming Windmill pasture. The bottom-line is that the early higher intensity management created a habitat with shorter (Leis et al. 2013) and sparser vegetation favored by Western Meadowlark for nesting and brood rearing (Dechant et al. 1999 (revised 2002)) and the later management produces taller and denser vegetation favored by Eastern Meadowlark (Gransfors et al 1996, Hull 2003). Dickcissel favored vegetation produced by the later management intensity as well (Dechant et al. 1999 (revised 2002), Dechant et al. 2003, Hull 2003).

Although results from monitoring could not identify significant population trends in 14 species, five of these species were found to be declining in the bird conservation region - Eastern Kingbird, Grasshopper Sparrow, Horned Lark, Northern Bobwhite, and Red-winged Blackbird. Therefore, it would suggest that the current management practice on the Preserve is at least having no significant negative impact on their numbers. It can be reasonably presumed that the current management practice created habitat favorable to another species, the Henslow's Sparrow. Henslow's Sparrow are increasing regionally, and the fact they were not recorded on the park during the breeding season until 2006, and then have been recorded in increasing numbers since (Appendix 1), support this presumption.

The trend in increasing diversity on the Preserve is a positive sign favoring less intense management in the conservation of the bird community as a whole. This is especially true for many of the breeding grassland obligate species - Dickcissel, Eastern Meadowlark, Greater Prairie-chicken, Henslow's Sparrow, and Upland Sandpiper (U.S. Geological Survey 2014) - all have increasing populations trend corresponding to the significant increase in diversity. Although species richness and the distribution of individuals within species did not increase significantly, both values trended positively over the 13 monitoring years.

While changes in population sizes of other common and widely distributed species on the Preserve make them good species for assessing changing habitat conditions, weather may play a role in habitat present and should always be considered. In spite of improving habitat structure on the Preserve, declining Red-winged Blackbird populations suggest that climate can override the effects of management in some cases. Drought conditions across Kansas since 2011 (National Weather Service Weather Forecast Office 2014) have reduced brushy-cattail habitat along waterways and ponds on the Preserve, habitat that is utilized by the Red-winged Blackbird for roosting (Thompson et al. 2011). In the absence of suitable habitat, Red-winged Blackbird numbers declined.

Vegetation management decisions should consider the potential impacts to bird habitat especially for those species identified as *species of concern* for the Eastern Tallgrass Prairie Bird Conservation Region. However, species once common to the Preserve such as the Red-winged Blackbird need consideration in a broader context of bird conservation when making management decisions.

Conclusions

Since initiating breeding bird surveys at TAPR in 2001, HTLN and Preserve staff, and volunteers have surveyed 1682 plots over 13 years, and recorded 113 different species. Ninety-four of the species recorded are permanent or summer residents to the area with the potential to breed within the Preserve. Less intense management of the habitat in recent years has had a positive effect on many species and has increased the bird community diversity on the Preserve. Comparing

individual population trends to those from the region found that the Preserve's current habitat is either favorable or less-restrictive for many bird species than that found in the region.

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Appendix

Appendix 1. Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using DISTANCE software) of breeding bird species at Tallgrass Prairie National Preserve, Kansas during the 2001-2014 (excluding 2003) spring bird surveys.

Common name	Proportion of plots occupied												
	Abundance												
	2001	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	n=176	n=260	n=97	n=97	n=99	n=89	n=95	n=58	n=260	n=58	n=54	n=58	n=259
Brown-headed Cowbird	0.34	0.48	0.35	0.40	0.36	0.42	0.35	0.38	0.43	0.40	0.31	0.53	0.50
	271	535	295	452	462	535	582	230	454	526	529	394	706
Dickcissel*	0.34	0.37	0.29	0.39	0.49	0.46	0.68	0.74	0.53	0.67	0.83	0.74	0.63
	1239	1643	1307	1537	2584	1900	2997	2877	2096	2455	3873	3529	2877
Eastern Kingbird	0.02	0.03	0.05	0.04	0.07	0.08	0.02	0.05	0.01	0.00	0.02	0.05	0.03
	16	131	146	146	200	287	60	147	33	0	52	147	120
Eastern Meadowlark	0.16	0.02	0.01	0.00	0.00	0.01	0.35	0.66	0.70	0.67	0.61	0.69	0.76
	240	9	11	0	0	25	539	997	1267	921	824	1458	1478
Eastern Wood-pewee	0.03	0.05	0.07	0.14	0.14	0.15	0.05	0.22	0.05	0.21	0.13	0.21	0.04
	76	72	193	358	323	420	197	690	144	736	445	690	124
Grasshopper Sparrow	0.58	0.56	0.61	0.57	0.51	0.54	0.61	0.48	0.62	0.22	0.19	0.57	0.59
	7210	6416	6994	6665	6127	6995	7897	5229	6600	2202	1626	6880	7242
Great Crested Flycatcher	0.02	0.05	0.24	0.15	0.14	0.15	0.06	0.07	0.05	0.05	0.09	0.12	0.07
	136	123	1029	535	524	583	252	275	169	207	370	482	324
Greater Prairie-chicken	0.01	0.02	0.01	0.00	0.01	0.00	0.01	0.00	0.04	0.00	0.04	0.00	0.03
	33	15	20	0	--	0	20	0	97	0	36	0	52
Henslow's Sparrow	0.00	0.00	0.00	0.00	0.01	0.01	0.07	0.07	0.07	0.16	0.04	0.07	<0.01
	0	0	0	0	66	37	483	226	353	1017	61	226	13
Horned Lark	0.02	0.00	0.24	0.09	0.10	0.04	0.00	0.02	0.03	0.00	0.00	0.02	0.02
	56	0	748	306	333	74	0	57	114	0	0	57	51
Killdeer	0.06	0.10	0.14	0.21	0.19	0.09	0.07	0.03	0.06	0.07	0.02	0.03	0.04
	34	102	244	365	298	133	62	51	57	102	0	51	80
Lark Sparrow	0.01	0.07	0.03	0.06	0.02	0.09	0.07	0.00	0.02	0.00	0.00	0.00	0.06
	32	428	401	229	56	562	410	0	--	0	0	0	408

Appendix 1. (cont.) Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using DISTANCE software) of breeding bird species at Tallgrass Prairie National Preserve, Kansas during the 2001-2014 (excluding 2003) spring bird surveys.

Common name	Proportion of plots occupied												
	Abundance												
	2001 n=176	2002 n=260	2004 n=97	2005 n=97	2006 n=99	2007 n=89	2008 n=95	2009 n=58	2010 n=260	2011 n=58	2012 n=54	2013 n=58	2014 n=259
Mourning Dove	0.06 10	0.05 49	0.01 19	0.02 19	0.02 18	0.04 62	0.09 135	0.10 126	0.04 42	0.03 --	0.15 305	0.19 189	0.07 92
Northern Bobwhite	0.00 0	0.03 1	0.04 3	0.08 11	0.11 15	0.07 7	0.04 9	0.21 30	0.04 6	0.14 8	0.26 13	0.12 18	0.04 7
Northern Cardinal	0.02 40	0.06 178	0.03 183	0.07 293	0.04 108	0.08 279	0.03 187	0.12 490	0.02 68	0.16 551	0.13 592	0.21 857	0.05 219
Red-bellied Woodpecker	0.02 45	0.06 71	0.05 164	0.06 110	0.06 188	0.04 90	0.05 84	0.03 137	0.01 31	0.14 412	0.15 541	0.19 595	0.03 103
Red-winged Blackbird	0.05 86	0.15 180	0.23 189	0.16 164	0.20 217	0.17 188	0.11 75	0.17 110	0.15 138	0.14 123	0.15 162	0.19 123	0.07 61
Tufted Titmouse	0.01 34	0.09 93	0.09 249	0.03 93	0.09 244	0.10 305	0.03 95	0.00 0	0.03 104	0.12 364	0.07 335	0.17 572	0.04 105
Upland Sandpiper	0.24 192	0.57 203	0.63 45	0.46 45	0.49 15	0.37 66	0.32 108	0.33 152	0.24 28	0.29 278	0.30 190	0.16 177	0.17 108
Western Meadowlark	0.21 211	0.68 714	0.76 1148	0.69 1373	0.74 1202	0.66 759	0.34 511	0.00 0	0.03 33	0.00 0	0.00 0	0.02 0	0.00 4

*Bolded species names are those species considered of conservation concern for the Eastern Tallgrass Prairie Bird Conservation Region (U.S. Fish and Wildlife Service 2008).

Appendix 2. Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using bird within 100-m of plot center) of breeding bird species at Tallgrass Prairie National Preserve, Kansas during the 2001-2014 (excluding 2003) spring bird surveys.

Common name	Proportion of plots occupied Abundance												
	2001 n=176	2002 n=260	2004 n=97	2005 n=97	2006 n=99	2007 n=89	2008 n=95	2009 n=58	2010 n=260	2011 n=58	2012 n=54	2013 n=58	2014 n=259
American Crow	0.01 --*	0.07 --	0.05 --	0.02 --	0.05 --	0.04 --	0.01 --	0.05 --	<0.01 --	0.10 48	0.11 78	0.14 24	0.03 16
American Goldfinch	0.01 32	<0.01 11	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.01 5	0.02 48	0.04 52	0.05 97	0.05 92
American Robin	0.00 0	0.00 0	0.01 --	0.00 0	0.00 0	0.00 0	0.00 0	0.05 48	0.02 16	0.00 0	0.00 0	0.00 0	0.01 5
Baltimore Oriole	0.00 0	0.00 0	0.00 0	0.06 87	0.07 71	0.04 79	0.06 74	0.09 121	0.01 22	0.09 97	0.02 26	0.07 72	0.01 5
Bank Swallow	0.01 --	0.05 --	0.05 --	0.03 --	0.02 --	0.00 0	0.05 44	0.00 0	0.06 --	0.05 --	0.02 26	0.07 --	0.05 11
Barn Swallow	0.03 --	0.01 --	0.08 --	0.09 --	0.10 --	0.01 --	0.01 --	0.12 24	0.06 --	0.10 --	0.13 52	0.10 --	0.20 16
Barred Owl	0.01 16	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.03 24	0.04 52	0.00 0	<0.01 5
Bell's Vireo**	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.04 26	0.00 0	0.02 11
Belted Kingfisher	0.01 --	0.00 0	0.01 14	0.01 --	0.00 0	0.01 --	0.01 15	0.00 0	<0.01 --	0.00 0	0.00 0	0.02 24	<0.01 5
Bewick's Wren	0.01 16	0.02 16	0.02 29	0.02 29	0.00 0	0.03 31	0.02 59	0.00 0	0.00 0	0.00 0	0.00 0	0.02 48	0.00 0
Black-billed Cuckoo	0.01 --	<0.01 5	0.00 0	0.07 29	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0
Black-capped Chickadee	0.01 16	0.03 54	0.05 72	0.02 29	0.00 0	0.00 0	0.02 44	0.02 24	<0.01 5	0.05 97	0.09 182	0.07 97	0.01 11
Blue-gray Gnatcatcher	0.01 16	0.00 0	0.02 29	0.05 72	0.04 57	0.03 47	0.05 74	0.02 48	0.01 11	0.05 121	0.04 52	0.14 242	0.03 49

Appendix 2. (cont.) Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using bird within 100-m of plot center) of breeding bird species at Tallgrass Prairie National Preserve, Kansas during the 2001-2014 (excluding 2003) spring bird surveys.

Common name	Proportion of plots occupied												
	Abundance												
	2001 n=176	2002 n=260	2004 n=97	2005 n=97	2006 n=99	2007 n=89	2008 n=95	2009 n=58	2010 n=260	2011 n=58	2012 n=54	2013 n=58	2014 n=259
Blue Grosbeak	0.00 0	0.00 0	0.02 43	0.00 0	0.00 0	0.00 0	0.01 15	0.00 0	0.00 0	0.00 0	0.02 26	0.00 0	0.00 0
Blue Jay	0.02 8	0.05 --	0.04 58	0.10 43	0.08 14	0.07 16	0.02 --	0.09 145	0.01 --	0.10 97	0.09 208	0.14 121	0.02 --
Brown Thrasher	0.02 32	0.05 27	0.07 29	0.02 14	0.05 57	0.02 0	0.01 30	0.03 24	0.04 5	0.02 48	0.00 0	0.00 0	0.01 5
Canada Goose	0.00 0	0.01 --	0.05 --	0.01 --	0.05 --	0.02 --	0.01 --	0.00 0	0.01 --	0.00 0	0.00 --	0.00 --	0.01 --
Carolina Wren	0.02 24	0.00 0	0.00 0	0.02 29	0.02 28	0.02 31	0.02 15	0.00 0	<0.01 5	0.09 121	0.06 52	0.09 121	0.01 5
Cattle Egret	0.01 --	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0
Cedar Waxwing	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.02 483	0.00 0
Chipping Sparrow	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.07 169	0.01 168
Cliff Swallow	0.07 --	0.01 --	0.00 0	0.00 0	0.00 0	0.01 --	0.00 0	0.02 --	0.02 --	0.00 0	0.00 0	0.00 0	0.02 --
Common Grackle	0.01 --	0.00 0	0.01 14	0.01 --	0.01 --	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.06 --	0.00 0	0.00 0
Common Nighthawk	0.10 24	0.18 11	0.03 --	0.26 --	0.11 --	0.13 --	0.07 15	0.07 24	0.08 11	0.02 --	0.15 78	0.03 24	0.04 5
Common Yellowthroat	0.00 0	0.02 22	0.00 0	0.00 0	0.00 0	0.00 0	0.01 15	0.00 0	0.01 11	0.00 0	0.00 0	0.00 0	0.02 43
Downy Woodpecker	0.01 16	0.02 5	0.00 0	0.00 0	0.00 0	0.00 0	0.01 15	0.00 0	<0.01 5	0.03 72	0.06 78	0.09 121	0.00 5

Appendix 2. (cont.) Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using bird within 100-m of plot center) of breeding bird species at Tallgrass Prairie National Preserve, Kansas during the 2001-2014 (excluding 2003) spring bird surveys.

Common name	Proportion of plots occupied												
	Abundance												
	2001 n=176	2002 n=260	2004 n=97	2005 n=97	2006 n=99	2007 n=89	2008 n=95	2009 n=58	2010 n=260	2011 n=58	2012 n=54	2013 n=58	2014 n=259
Eastern Bluebird	0.01	0.00	0.00	0.03	0.02	0.02	0.01	0.05	<0.01	0.00	0.04	0.03	0.04
	8	0	0	14	57	32	59	72	5	0	26	72	65
Eastern Phoebe	0.00	0.01	0.05	0.01	0.01	0.01	0.01	0.03	0.00	0.00	0.00	0.02	0.02
	0	11	29	--	--	16	15	48	0	0	0	--	32
Eastern Towhee	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01	0.00	0.00	0.00	0.00
	8	0	0	0	0	0	0	0	5	0	0	0	0
Field Sparrow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
	0	5	0	0	0	0	0	0	5	0	0	0	16
Gray Catbird	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8	0	0	14	0	0	0	0	0	0	0	0	0
Great blue Heron	0.01	<0.01	0.01	0.03	0.03	0.02	0.02	0.10	0.02	0.03	0.02	0.00	0.02
	--	--	--	--	--	--	--	48	5	24	26	0	--
Great Horned Owl	0.00	<0.01	0.00	0.01	0.00	0.00	0.00	0.00	<0.01	0.00	0.00	0.00	0.00
	0	--	0	--	0	0	0	0	--	0	0	0	0
Great-tailed Grackle	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
	--	0	--	--	0	0	0	0	0	0	0	0	0
Hairy Woodpecker	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
	8	0	43	14	0	0	0	24	0	0	0	0	0
House Finch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	0	0	0	0	0	0	0	0	0	0	26	0	0
House Wren	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.00
	0	0	0	0	14	0	0	0	0	24	26	48	0
Indigo Bunting	0.01	0.01	0.00	0.00	0.00	0.02	0.07	0.03	<0.01	0.07	0.04	0.07	0.03
	8	16	0	0	0	32	118	72	5	169	78	121	70
Kentucky Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
	0	0	0	0	0	0	0	0	0	--	0	0	0

Appendix 2. (cont.) Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using bird within 100-m of plot center) of breeding bird species at Tallgrass Prairie National Preserve, Kansas during the 2001-2014 (excluding 2003) spring bird surveys.

Common name	Proportion of plots occupied												
	Abundance												
	2001 n=176	2002 n=260	2004 n=97	2005 n=97	2006 n=99	2007 n=89	2008 n=95	2009 n=58	2010 n=260	2011 n=58	2012 n=54	2013 n=58	2014 n=259
Loggerhead Shrike	0.00	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0	--	0	0	0	0	0	0	0	0	0	0	5
Louisiana Waterthrush	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
	0	0	0	0	0	0	0	0	0	72	0	0	0
Mallard	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01	0.00	0.00	0.00	<0.01
	0	0	0	0	0	0	0	0	--	0	0	--	--
Northern Flicker	0.00	<0.01	0.01	0.01	0.00	0.00	0.00	0.14	0.00	0.05	0.11	0.03	0.00
	0	--	--	14	0	0	0	169	0	--	130	--	0
Northern Harrier	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	0	0	0	--	0	--	0	0	5	0	0	0	0
Northern Mockingbird	0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.03	<0.01	0.02	0.00	0.02	0.02
	0	0	0	--	--	16	15	24	38	--	0	24	5
Northern Parula	0.00	0.01	0.04	0.01	0.02	0.02	0.03	0.03	0.02	0.09	0.02	0.09	0.02
	0	16	43	14	28	31	59	48	11	145	52	121	32
Northern Rough-winged Swallow	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	--	0	0	0	0	0	0	0	--	0	0	0	0
Orchard Oriole	0.01	0.01	0.01	0.00	0.06	0.00	0.01	0.00	0.04	0.03	0.04	0.05	0.02
	16	16	14	0	71	0	--	0	43	72	52	24	16
Prothonotary Warbler	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01	0.02	0.00	0.00	0.00
	16	0	0	0	0	0	0	0	5	24	0	0	0
Red-eyed Vireo	0.00	0.02	0.03	0.03	0.05	0.04	0.02	0.02	0.01	0.17	0.07	0.16	0.02
	0	27	43	43	85	63	29	24	16	193	104	217	27
Red-headed Woodpecker	0.00	<0.01	0.02	0.02	0.03	0.00	0.00	0.05	<0.01	0.02	0.00	0.03	0.00
	0	--	43	29	14	0	0	48	5	24	0	24	0
Red-tailed Hawk	0.00	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.05	0.04	0.02	0.01
	0	0	--	--	14	0	0	0	0	--	52	--	--

Appendix 2. (cont.) Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using bird within 100-m of plot center) of breeding bird species at Tallgrass Prairie National Preserve, Kansas during the 2001-2014 (excluding 2003) spring bird surveys.

Common name	Proportion of plots occupied												
	Abundance												
	2001 n=176	2002 n=260	2004 n=97	2005 n=97	2006 n=99	2007 n=89	2008 n=95	2009 n=58	2010 n=260	2011 n=58	2012 n=54	2013 n=58	2014 n=259
Ring-necked Pheasant	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.02 --	0.00 0	0.00 0	0.00 0	0.02 --	<0.01 --
Ruby-throated Hummingbird	0.00 0	0.00 0	0.00 0	0.01 --	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.02 26	0.02 24	0.00 0
Scarlet Tanager	0.00 0	0.00 0	0.01 14	0.00 0	0.00 0	0.00 0	0.01 30	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0
Scissor-tailed Flycatcher	0.00 0	0.01 --	0.03 58	0.02 14	0.04 14	0.03 79	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.01 5
Spotted Sandpiper	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	<0.01 103
Summer Tanager	0.00 0	0.02 22	0.02 29	0.03 14	0.03 28	0.06 79	0.01 15	0.02 24	0.01 11	0.07 121	0.02 26	0.05 48	0.02 27
Turkey Vulture	0.01 --	0.01 --	0.02 --	0.01 --	0.03 --	0.01 --	0.02 --	0.10 24	0.05 11	0.05 --	0.07 52	0.14 --	0.03 --
Warbling Vireo	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.05 48	0.04 52	0.05 72	0.00 0
Western Kingbird	0.02 8	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	<0.01 5	0.02 0	0.02 26	0.03 0	0.00 0
White-breasted Nuthatch	0.00 0	0.04 27	0.01 29	0.04 29	0.05 71	0.03 63	0.02 29	0.03 72	0.01 11	0.07 97	0.20 259	0.05 72	0.01 11
Wild Turkey	0.00 0	<0.01 --	0.02 --	0.01 --	0.00 0	0.02 16	0.00 0	0.02 24	0.02 5	0.00 0	0.06 130	0.02 --	0.03 70
Wood Duck	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.01 31	0.00 0	0.02 24	0.01 --	0.00 0	0.00 0	0.00 0	0.01 27
Yellow-billed Cuckoo	0.01 8	0.05 5	0.10 101	0.00 0	0.00 0	0.00 0	0.04 59	0.05 24	0.00 0	0.07 24	0.04 52	0.03 24	0.00 0

Appendix 2. (cont.) Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using bird within 100-m of plot center) of breeding bird species at Tallgrass Prairie National Preserve, Kansas during the 2001-2014 (excluding 2003) spring bird surveys.

Common name	Proportion of plots occupied												
	Abundance												
	2001 n=176	2002 n=260	2004 n=97	2005 n=97	2006 n=99	2007 n=89	2008 n=95	2009 n=58	2010 n=260	2011 n=58	2012 n=54	2013 n=58	2014 n=259
Yellow-breasted Chat	0.00 0	0.02 16	0.00 0	0.00 0	0.00 0	0.01 --	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0
Yellow-throated Vireo	0.01 8	0.01 5	0.03 14	0.03 43	0.00 0	0.01 16	0.03 44	0.03 48	0.01 11	0.02 24	0.00 0	0.00 0	0.01 11
Yellow Warbler	0.03 48	0.00 0	0.04 43	0.02 29	0.04 85	0.00 0	0.01 15	0.00 0	<0.01 5	0.02 24	0.04 52	0.03 48	<0.01 11

* — denotes when a species was present on a plot but outside 100-m of plot center therefore their annual abundance value could not be calculated.

**Bolded species names are those species considered of conservation concern for the Eastern Tallgrass Prairie Bird Conservation Region (U.S. Fish and Wildlife Service 2008).

Appendix 3. Regional trends in breeding birds recorded on Tallgrass Prairie National Preserve, Kansas that did not have enough observations to calculate within park trends, years 2001-2013.

Common name	Annual percent change in population size	95% Confidence Interval	
		Lower	Upper
American Crow	-2.00	-2.75	-1.23
American Goldfinch	-0.97	-1.88	-0.07
American Robin	1.21	0.73	1.70
Baltimore Oriole	-0.71	-1.51	0.03
Bank Swallow	-0.08	-4.89	4.48
Barn Swallow	-0.69	-1.46	0.13
Barred Owl	4.13	0.58	7.05
Bell's Vireo	-0.10	-2.58	2.47
Belted Kingfisher	-0.90	-3.21	1.27
Bewick's Wren	0.23	-6.42	6.58
Black-billed Cuckoo	-4.35	-7.89	-1.33
Black-capped Chickadee	-0.57	-2.28	1.16
Blue Jay	-1.99	-2.79	-1.16
Blue-gray Gnatcatcher	0.82	-1.42	2.86
Blue Grosbeak	3.45	1.98	5.03
Blue-winged Teal*	9.04	-1.30	24.01
Brown-headed Cowbird	-0.13	-0.83	0.67
Brown Thrasher	-1.26	-1.85	-0.55
Burrowing Owl*	--	--	--
Canada Goose	10.87	5.01	18.29
Carolina Wren	6.18	3.96	8.49
Cattle Egret	-6.82	-21.21	11.85
Cedar Waxwing	1.13	-1.16	3.51
Chipping Sparrow	3.02	2.11	3.95
Cliff Swallow	17.08	12.63	20.48
Common Grackle	-2.71	-3.54	-1.89
Common Nighthawk	-0.61	-2.99	1.68
Common Yellowthroat	-1.30	-2.12	-0.49
Dickcissel	0.14	-0.75	1.11
Downy Woodpecker	-0.95	-2.14	0.18
Eastern Bluebird	2.00	0.42	3.58
Eastern Kingbird	-2.38	-3.33	-1.45
Eastern Meadowlark	-1.09	-1.81	-0.28
Eastern Phoebe	1.55	0.09	2.91
Eastern Towhee	1.39	0.13	2.68
Eastern Wood-pewee	-0.57	-1.57	0.38
Eurasian Collared-dove*	45.82	38.99	53.10
Field Sparrow	-1.03	-1.89	-0.09

Appendix 3. Regional trends in breeding birds recorded on Tallgrass Prairie National Preserve, Kansas that did not have enough observations to calculate within park trends, years 2001-2013.

Common name	Annual percent change in population size	95% Confidence Interval	
		Lower	Upper
Grasshopper Sparrow	-4.07	-5.63	-2.56
Gray Catbird	0.61	-0.20	1.37
Great Blue Heron	0.93	-0.67	2.46
Great Crested Flycatcher	0.17	-0.85	1.27
Great Egret*	11.25	4.72	18.67
Great Horned Owl	-2.47	-4.83	-0.38
Greater Prairie Chicken	-0.41	-8.48	21.34
Great-tailed Grackle	6.71	-2.40	18.68
Green Heron*	-2.82	-4.80	-1.18
Hairy Woodpecker	0.61	-1.56	2.86
Henslow's Sparrow	7.39	3.09	11.67
Horned Lark	-1.93	-2.90	-0.99
House Finch	-2.44	-4.59	-0.12
House Wren	0.12	-0.61	0.85
Indigo Bunting	-1.51	-2.13	-0.91
Kentucky Warbler	1.59	-1.79	4.01
Killdeer	1.27	0.42	2.14
Lark Sparrow	2.52	0.85	4.42
Loggerhead Shrike	-6.08	-8.68	-3.52
Louisiana Waterthrush	6.60	2.89	10.06
Mallard	0.38	-2.46	3.20
Mourning Dove	0.29	-0.26	0.88
Northern Bobwhite	-2.37	-3.62	-1.14
Northern Cardinal	0.56	0.08	1.06
Northern Flicker	--	--	--
Northern Harrier	0.69	-4.19	5.62
Northern Mockingbird	0.50	-0.63	1.64
Northern Parula	3.85	1.99	5.81
Northern Rough-winged Swallow	1.51	-0.49	3.29
Orchard Oriole	0.20	-1.42	1.86
Pileated Woodpecker*	6.09	3.56	8.96
Prothonotary Warbler	4.96	1.45	9.69
Red-bellied Woodpecker	2.10	1.12	3.08
Red-eyed Vireo	1.62	0.34	2.91
Red-headed Woodpecker	-3.50	-4.87	-2.10
Red-tailed Hawk	0.75	-0.46	1.86
Red-winged Blackbird	-1.47	-2.00	-1.00
Ring-necked Pheasant	-4.87	-7.06	-2.62

Appendix 3. Regional trends in breeding birds recorded on Tallgrass Prairie National Preserve, Kansas that did not have enough observations to calculate within park trends, years 2001-2013.

Common name	Annual percent change in population size	95% Confidence Interval	
		Lower	Upper
Ruby-throated Hummingbird	1.61	-0.84	3.66
Scarlet Tanager	1.01	-1.50	3.56
Scissor-tailed Flycatcher	0.79	-0.59	2.29
Spotted Sandpiper	1.62	-5.01	7.37
Summer Tanager	4.23	2.21	6.44
Tufted Titmouse	-0.05	-1.35	1.23
Turkey Vulture	7.93	5.84	9.90
Upland Sandpiper	-1.15	-2.71	0.51
Warbling Vireo	0.63	-0.28	1.54
Western Kingbird	1.99	-1.19	6.34
Western Meadowlark	-4.79	-6.99	-2.65
White-breasted Nuthatch	0.84	-1.05	2.56
Wild Turkey	10.01	5.39	14.62
Wood Duck	3.45	1.23	5.75
Yellow-billed Cuckoo	-2.63	-4.35	-0.86
Yellow-breasted Chat	0.10	-1.59	1.67
Yellow-throated Vireo	4.17	2.19	6.15
Yellow Warbler	-0.10	-1.61	1.47

* Species recorded between point transects or other times outside of 5-min survey periods.

Bolded species names are those species considered of conservation concern for the Eastern Tallgrass Prairie Bird Conservation Region (U.S. Fish and Wildlife Service 2008).

Regional trend data from BBS surveys (Sauer et al. 2014). Trend is defined as an interval-specific geometric mean of proportional changes in population size (Link and Sauer 1998), expressed as a percentage.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



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